Volume 42 MARCH, 1956 Number 3

Lubrication

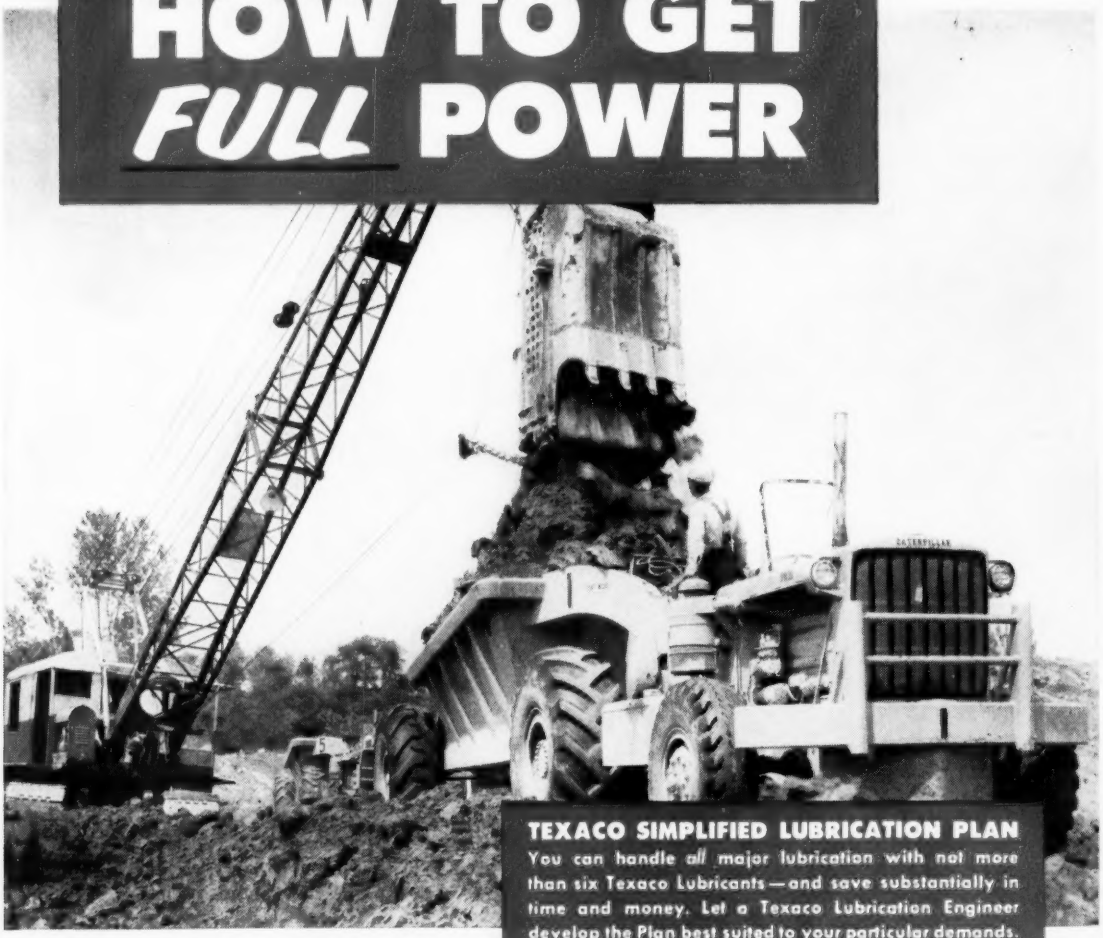
A Technical Publication Devoted to the Selection and Use of Lubricants

This Issue

HEAVY
CONSTRUCTION
EQUIPMENT

PUBLISHED BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

HOW TO GET *FULL* POWER



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FOR ALL CONTRACTORS' EQUIPMENT

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

Published by
The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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Change of Address: In reporting change of address kindly give both old and new addresses.

Heavy Construction Equipment

PROGRESS and expansion in the heavy construction field during recent years have been so rapid as to be almost beyond comprehension. Developments in new equipment and techniques have combined to convert the impossibilities of yesterday into the routine realities of today. Hills can be levelled; solid rock sliced; the course of rivers can be altered. Truly, the whole contour of the earth now can be reshaped by man with unbelievable speed and rapidity to fit his needs of the moment—whether they be super-highways, dams, tunnels, sewers, bridges, factory sites or new residential areas.

Statistics, dry though they may be, frequently are quite revealing. Those which have been compiled on heavy construction operations reflect well the rate at which activity in this field has expanded since the close of World War II. For example, in highway construction alone, the amounts spent since 1946 on both new projects and maintenance have increased at an average rate of $300 million and $100 million per year respectively. Or, expressed another way, the total expenditure in 1954 for highway construction, including both new operations and maintenance, was 46% greater than that in 1950 and 11% over that for 1953. Actually, in 1954 approximately $7.6 billion was spent on heavy construction operations, and conservative forecasts predict that by 1959 this figure will be doubled.

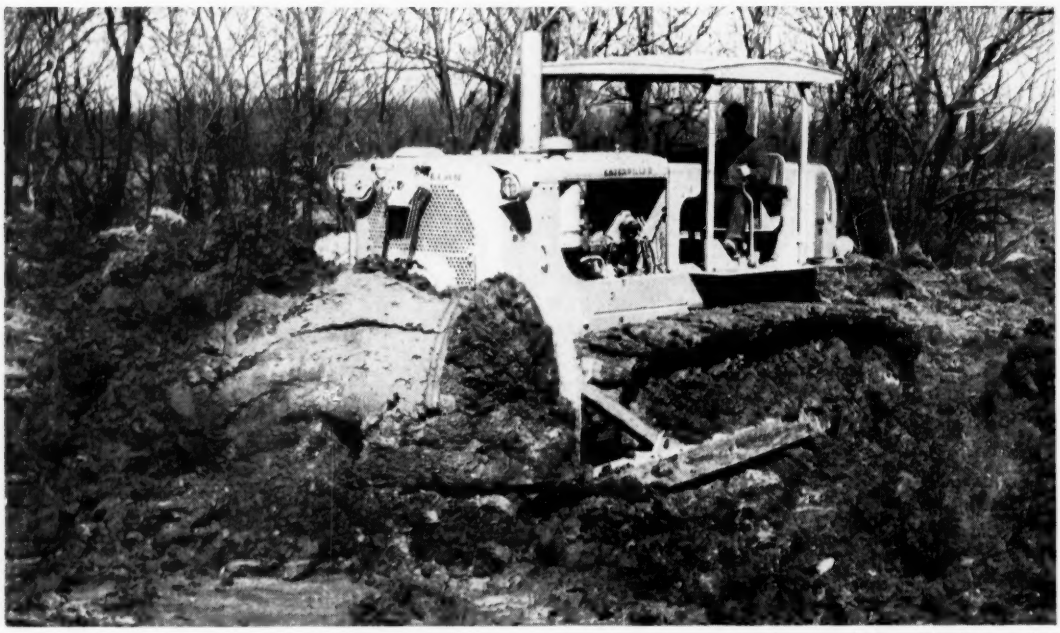
Operating costs can be reduced to a minimum and equipment life can be extended by:

(1) Adopting a simplified lubrication plan which will keep the number of lubricants on the job to a minimum but will still satisfy fully all of the lubrication requirements;

(2) Storing and handling lubricants properly so that chances of contamination will be minimized; and

(3) Establishing a preventive maintenance program which includes periodic mechanical and lubricant check-up and following it to the letter.

To describe, even sketchily, the recent developments in the equipment which make the current heavy construction operations possible — the tractor and its attachments, the shovel, the dragline, the scraper, the crusher, the grader, the excavator, and the loader, to mention some — would require volumes. However, if one could select a single word which would reflect the trends in equipment design that have prevailed during the past few years, it might very well be INCREASE — increase in engine horsepower, in speed, in unit load and capacity, in mobility and flexibility, in size and ruggedness, in ease of operation, and in features which make for more comfort and less strain on the operator. Full advantage is being taken of all the improvements that have been realized in the power units whether they be gasoline, diesel, or in some cases, LPG engines.



Courtesy of Caterpillar Tractor Co.

Figure 1 — 230-Drawbar Horsepower Turbocharged Tractor.

Fully automatic or semi-automatic transmissions have been adopted by many equipment manufacturers. Refinements continue to be made in the design of the hydraulically, electrically, or mechanically operated attachments which permit easier and more efficient operation. Thus, on the whole, new equipment tends to be larger and more powerful which increases the unit work capacity; but at the same time it is faster, more mobile and much easier to handle, all of which increases overall operating efficiency.

Now to revert to some additional pertinent facts and figures comparing equipment costs with total heavy construction expenditures. The accummulated evidence shows that the ratio of equipment value to construction value has been increasing steadily over the years. In 1929 the U. S. Bureau of the Census reported this ratio as 19.9%. A Bureau of Public Roads survey indicated that in 1935 for $100 million spent on highway construction, the value of the major equipment involved was $47.8 million, an "equipment ratio" of 47.8%. In 1949 a similar survey revealed the ratio to be 67%. In the field of highway maintenance, as separate from new construction, this equipment ratio is even higher. In 1954 the BPR reported that for maintenance operations, a dollar's worth of major equipment was required to perform a dollar's worth of annual maintenance, for a ratio of 100%. These figures emphasize very convincingly the tremendous investment involved in the purchase and ownership of heavy construction equipment.

Idle equipment represents an investment but it doesn't perform any work. It must be operating to be productive, and some very interesting statistics have been developed on the costs of keeping it in service. Of each dollar spent on heavy construction operations, 21.3 cents is equipment expense (items such as direct operating costs, repairs and depreciation). Of each dollar of equipment expense, 18.2 cents is for fuel but *only 3.3 cents is spent on lubricants, including oils and greases.* In other words, 21.3% of the total heavy construction costs is for equipment expense, but only about 0.7% is spent on lubricants.

Proper lubrication is a "must" if the equipment is to operate satisfactorily and efficiently. This is particularly true for today's modern machines with their increased speeds and loads and closer tolerances and clearances. The penalty for lubrication failures can be extremely heavy. When one compares the relatively insignificant cost of the lubricant to the replacement cost of the part to be lubricated and add to that the down time required to make the necessary repairs, it is certainly "penny wise and pound foolish" to make any compromise with lubricant quality—the risk is too great.

Thus the first step toward proper lubrication is to choose the right product—one which has built into it all of the properties and characteristics required to do the job. However, this is not sufficient in itself. The best lubricants in the world are of no real value until they are applied and applied properly—

Statistics quoted obtained from Gillette Publishing Company.

at the right time and in the right quantity. This involves establishing a definite lubrication schedule and adhering to it strictly.

Through the combination of proper lubrication and a good preventive maintenance schedule, the costs of keeping equipment in service can be reduced and at the same time the equipment life will be extended. It is hoped that the discussion to follow on lubrication and maintenance will be of some benefit to the operators of construction equipment.

SIMPLIFIED LUBRICATION PLAN

In order to meet the demands of industry in general, the petroleum companies have made available hundreds of different types and grades of lubricants represented by thousands of different brand names. From these, the construction machinery manufacturers prepare lubrication charts recommending the various grades or types of lubricants which they feel are best suited for their equipment. However, there has been little progress throughout industry toward standardizing lubrication recommendations. For example, one manufacturer will specify certain grades of lubricants for use on his equipment, while another manufacturer of the same type of equipment with similar basic lubrication requirements may recommend an entirely different set of products. Thus, individually the lubrication charts provided by the equipment manufacturers are usually excellent with respect to lubricant recommendations, but collectively they provide some problems and complications in the field. They are very useful on jobs where there is not a large variety of equipment or where the equipment may be all of one manufacturer. However on jobs where the number and variety of equipment are great, more products would be required than could be handled conveniently if each manufacturer's lubricant recommendations were followed to the letter. For example, a survey of equipment on a small road job revealed that to meet each specific lubricant recommendation would require five grades of motor oil, four grades of gear oil, three grades of gear and cable lubricant, six greases, a track roll lubricant, a cylinder oil, and a hydraulic oil, for a grand total of 21 different products.

Lubrication of construction equipment on the job is usually not performed under ideal conditions even at best. Time is always of the essence and frequently the weather conditions leave much to be desired. In such circumstances the contractor will be most reluctant to stock all of the different products required and to insist that his oilers abide by each manufacturer's lubricant recommendation. The personnel responsible for lubricating the equipment know from necessity that the number of lubricants used on the job must be reduced to a minimum. Lacking any other alternative, the contractors themselves or their lubrication engineers must decide upon a consolidated group of lubricants to be used where many have been recommended. Actually this is placing responsibility where it does not belong. What is needed is a carefully designed, simplified lubrication plan worked out in advance so that it will not be necessary to improvise simplification methods in the field.

Courtesy of Le Tourneau—Westinghouse Company

Figure 2 — 18-yard Struck Capacity Scraper with 300 Horsepower Engine.

After considerable study of the lubrication requirements of construction equipment, such a simplified plan has been devised. Actual experience on construction work, which has been confirmed by the military, indicates that six basic types of lubricants can satisfy the requirements of nearly all construction machinery. These are shown in the Chart along with the parts to be lubricated and interval between applications. The required characteristics of the six lubricants are discussed in the sections that follow.

Engine Oils

For gasoline engines as well as diesel engines powering construction machinery, it is necessary to use an engine crankcase oil which provides oxidation stability, corrosion resistance, detergent-dispersant characteristics, extreme pressure and anti-wear properties, rust protection, and foam prevention. These are the principal characteristics of engine oils generally known as the heavy-duty type.

Industry has come to recognize several different grades or classifications of these heavy-duty type engine oils. Basically an acceptable heavy-duty oil is generally recognized as an oil which complies with the requirements of Military Specification MIL-0-2104A. Increased detergent-dispersant properties may be found in those oils which have come to be known as "Supplement I" type oils. Actually there is no established specification covering this type of oil, although the engine test requirements to indicate an oil of this quality level are generally recognized by industry.

Beyond this quality level are the "Series II" oils or "Super-Duty" type oils. These products were developed originally to satisfy the requirements of Caterpillar as "Superior Lubricants (Series II)". More recently Caterpillar has announced a still further advancement in their engine oil requirements designated "Superior Lubricants (Series III)". Oils meeting "Series III" represent about the highest degree of detergency-dispersancy to be found in commercially available lubricating oils for internal combustion engines.

Gear Lubricants

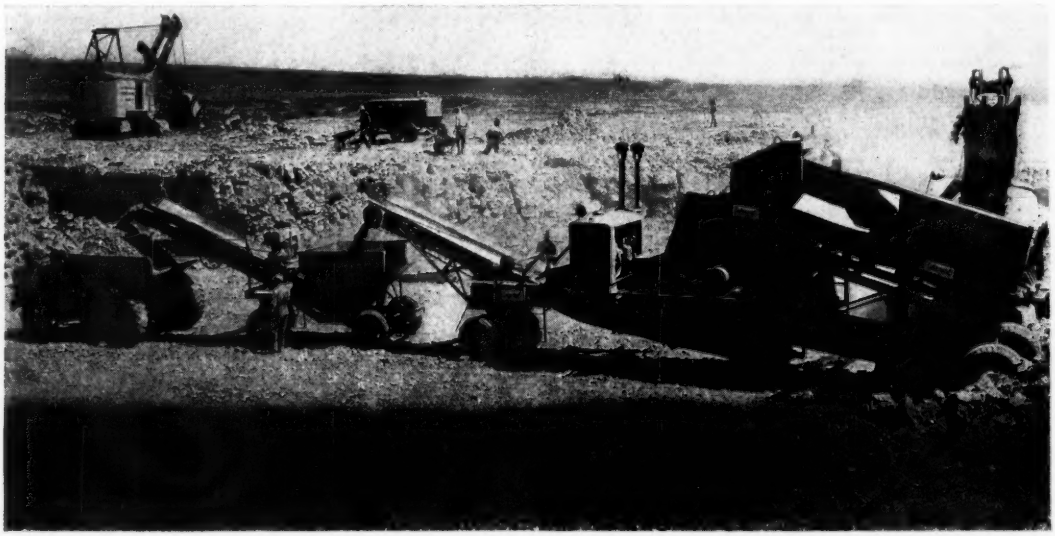
Many of the different types of gears, such as the ordinary spur or spiral-bevel where rolling contact occurs between the gear teeth, can be lubricated satisfactorily with a straight mineral oil. However, where there is a sliding contact between the gear teeth faces, as in hypoid or worm gears, the lubricants should be fortified to prevent scoring under heavy loads. These extreme pressure lubricants will also take care of slight misalignments or machining imperfections and frequently are used for breaking in plain gears.

Since a variety of gears is used in construction equipment, a gear oil containing extreme pressure properties is recommended to insure sufficient load carrying capacity for all types encountered. A good EP gear oil will absorb shock loads in the heaviest drives and still retain its load carrying properties and will be resistant to oxidation or thickening, corrosion and foaming.

Hydraulic or Compression Lubricants

A highly refined straight mineral oil of the proper viscosity has been and can be used satisfactorily for lubricating air compressors, electric motors, generators, bearings, and hydraulic mechanisms.

However, for hydraulic systems in particular there is usually a tremendous advantage in using a premium grade hydraulic oil. These oils have been so



Courtesy of Iowa Manufacturing Company

Figure 3 — Portable Primary Double Impeller Impact Breaker.

SIMPLIFIED LUBRICATION PLAN FOR LARGE CONSTRUCTION PROJECTS

PART REQUIRING LUBRICATION	INTERVAL, HOURS	90-32°F.	32-10°F.
Gasoline, LPG, and Diesel Engines (including misc. oiling parts, such as Air Cleaners, Generators, etc.	100	Heavy Duty Engine Oil SAE-30	SAE 20-20W
Gear Boxes	1000		
Bearing (severe service)	10		
Chain Drives	100		
Flexible Couplings	1000	E. P. Gear Lubricant SAE-140	SAE-90
Universal Joints	1000		
Other oil lubricated parts in heavy duty services	10		
Hydraulic Mechanisms Air Compressors Electric Motors Generators and Bearings	1000	Premium Grade Hydraulic Oil SAE-30	SAE-10
Grease Fittings Plain Bearings Track Rollers	10	General Multipurpose Grease No. 1 or 0	No. 00
Hand Packed Bearings	100		
Wheel Bearings	1000	Wheel Bearing Grease No. 2	
Roller Bearings	100		
Ball Bearings	100		
Exposed Gears Cables Wire Ropes	As required	Cable Lubricant	

compounded as to resist foaming, oxidation, and sludge formation, and at the same time to protect the system against rust and corrosion. Just one or two flakes of rust passing through precision made pumps or valves may so mar the surface as to affect seriously the efficiency of these parts. Likewise, sludge, as might be formed from oxidation of the oil, can cause sluggish operation of the mechanisms, will increase wear and will eventually reduce clearances, plug lines and valves, and cause the system to become inoperative. Consequently for smooth, trouble-free operation of the hydraulic system, a premium grade oil should be employed, and in line with consolidation of lubricants, use the same product for air compressors, electric motors, generators, and oil lubricated bearings, realizing the benefits of this type oil on this equipment also.

General Multipurpose Grease

Greases and semi-fluid lubricants are now available which not only form a tough, durable, long lasting film and cling to the parts to be lubricated, but which also are very water resistant. Such products are especially suited for track rollers and other bearings which are exposed to mud and water. Track rollers in particular require a lubricant which will be sufficiently fluid to flow through bearing passages and still be non-fluid enough to minimize leakage from worn bearings.

Ball and Roller Bearing Lubricant

Wheel bearings and hand packed ball and roller bearings, such as the clutch release and pilot bearings, require a heavier grease which will provide a tough, adhesive film to cushion against shock and make parts last longer. A good grease for such application will provide ideal film lubrication inside a bearing but at the same time will maintain its original consistency at the outer edges, sealing itself in and keeping out grit and water.

Exposed Gears and Cable Lubricant

Open gears require a lubricant which will cushion load shocks, decrease noise, and reduce wear. It must not channel or throw-off, but should cling to tooth surfaces and follow through from gear to

DIESEL FUEL SPECIFICATIONS

	ASTM Diesel Fuels					GMC Detroit Diesel Engine Division			
	Grade 1-D	Grade 2-D	Buda	Caterpillar (*See Note 1*)	Cummins	Class A	Class B (*See Recommendations Below*)	Class C	Class D
Gravity, °API	.....	.....	30–35	26 Min.	30–42	.....	.....	.....	.....
Flash, °F., Min.	100	125	150	100	.....	.....	.....	.....	.....
Viscosity, SSU @ 100° F.	.....	(32–45)	(34–41)	40 Max.	(34–42)	.....	.....	.....	.....
Viscosity, Kin. @ 100°F., cs.	1.4 Min.	1.8–5.8	2.5–4.5	(4.3 Max.)	2.4–5.0	.....	.....	.....	.....
Pour, °F.	10°F. Below Use Temp.		0	20 Max.	10°F. Below Use Temp.	.....	.....	.....	.....
Sulfur, % Max.	0.50	1.0	0.5	.....	1.0	0.25	0.50	0.50	0.75
Carbon Residue, % Max.	0.15	0.35	0.20	0.35	0.25	.....	.....	.....	.....
B.S.&W., % Max.	Trace	0.10	Trace	0.10	0.05	.....	.....	.....	.....
Ash, % Max.	0.01	0.02	0.02	.....	0.01	.....	.....	.....	.....
Corrosion, Copper Strip	Pass @ 122°F.		.....	.....	Pass @ 212°F.	.....	.....	.....	.....
Alkali & Min. Acids	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cetane No., Min.	40	40	46–60	.....	45	45	45	40	40
Distillation, °F.									
IBP, Min.	.....	.....	.....	.....	.....	.....	.....	.....	.....
10%, Max.	.....	.....	.....	.....	460	.....	.....	.....	.....
50%, Max.	.....	.....	.....	.....	.....	.....	.....	.....	.....
90%, Max.	.....	675	650	675	675	550	575	625	675
E. P., Max.	625	.....	700	.....	725	575	625	675	725

	GMC Truck	Harnischfeger	Hercules	International Harvester	Mack (*See Note 2*)	Murphy	Oliver	Waukesha	Superior
Gravity, °API	.....	(This mfr.	.....	30 Min.	32–39	.....	(This mfr.	.....	30 Min.
Flash, °F., Min.	.....	specifies	115	125	Legal	150	specifies	.....	.....
Viscosity, SSU @ 100°F.	.....	ASTM 2-D	(32–98)	.....	(34–39)	34 Min.	ASTM 1-D	30–50	35–50
Viscosity, Kin. @ 100°F., cs.	.....	except for	2.0–20.0	.....	2.5–4.0	.....	for year-round	.....	.....
Pour, °F.	10°F. Below Use Temp.	0.5% Max. sulfur content)	10°F. Below Use Temp.	10°F. Below Use Temp.	10°F. Below Use Temp.	10° F. Below Use Temp.	use ASTM 2-D is specified for warm weather operation)	10°F. Below Use Temp.	.....
Sulfur, % Max.	0.5		1.5	0.50	0.50	0.5		0.70	1.0
Carbon Residue, % Max.	.....		0.20	0.25	0.20	0.20		2.0	0.50
B.S.&W., % Max.	.....		0.05	None	0.05	0.05		0.5	0.10
Ash, % Max.	.....		0.02	0.02	0.01	0.01		.....	0.02
Corrosion, Copper Strip	.....		.....	Pass @ 212°F.	Pass @ 212°F.	.....		.....	.....
Alkali & Min. Acids	.....		.....	.....	Neutral	None		.....	.....
Cetane No., Min.	45		45	40	45	45		45	35–50
Distillation, °F.									
IBP, Min.	[2]20		.....	325	320	(98% Recovered at 600-650°F.)		.....	.....
10%, Max.	.....		.....	.....	.....			.....	.....
50%, Max.	.....		.....	475	475–500			.....	.....
90%, Max.	550		.....	.....	.....			.....	.....
E. P., Max.	600		.....	610–675	675	.....		.....	.....

NOTES:

[1]*Caterpillar Specifies "Commercial No. 2 Domestic Furnace Oils". Specifications Shown Are For ASTM Fuel Oil Grade No. 2.*

[2]*ASTM Grade 1-D may be used at sacrifice of performance and economy.*

GMC Fuel Class Recommendations

Tybe Service	*Ambient Air Temp. °F. Above*			
	80	*40*	*0*	*−20*
Marine	*C*	*B*	*B*	*A*
Industrial & RR	*C*	*C*	*B*	*A*
Heavy Mobile	*D*	*C*	*C*	*B*

gear even at high pressures, temperatures, and peripheral speeds.

For cables and wire ropes, the product must penetrate into and preserve the core, preventing collapse. It should seal each wire in a tough, viscous film to reduce internal friction and wear, keep out moisture, prevent corrosion, and extend the rope life.

Lubricants have been developed which have been endowed with the properties necessary to satisfy both of the foregoing requirements. Consequently, if properly selected, a single lubricant may be used for both open gears and wire ropes.

These, then, are the basic properties and characteristics of six types of lubricants which will satisfy most of the main lubrication requirements of heavy construction equipment. This simplified plan is flexible and can be modified and adjusted to meet any given situation. It should be regarded as a guide in assisting operators of construction equipment to reduce their inventory of different kinds of lubricants to a minimum with the assurance that their machines will be lubricated satisfactorily.

Although the recommendations outlined cover the vast majority of equipment, there may always be certain exceptions or conditions which will necessitate special lubricant recommendations. For example special products may be required for such applications as water pumps (shaft seal type), fifth wheels, electric motors and generators (antifriction), rock drills, steam cylinders, waste packed car journals, brake drum bearings on power shovels (severe service), concrete forms, and rust proofing of equipment in storage.

Also it is not advisable to make a general blanket recommendation for torque convertors and hydraulic couplings. Since there are wide variations in lubricant requirements for these components, product recommendations should be made on an individual basis.

Generally speaking, construction equipment manufacturers look very favorably on a simplified lubrication plan as evidenced by the following comments.

A Diesel Engine manufacturer: "Many contractors and users of large quantities of lubricants should profit by such a program."

A manufacturer of generator sets: "We appreciate the advantage of standardizing on a minimum number of lubricants".

A manufacturer of road maintenance equipment: "We believe that a simplified and standardized lubrication program has been needed for a long time."

An excavator manufacturer: "We believe that the types and grades of lubricants can be materially reduced so that a contractor will not be required to carry so many different kinds of lubricants to properly service a piece of construction machinery".

A manufacturer of loaders: "We certainly approve such a plan. We believe the fewer lubricants specified, the more likely that the correct one will be used."

A manufacturer of paving equipment: "It is not only a nuisance to the contractor but could be detrimental if a contractor is compelled to handle too many different types of greases and oils."

FUELS

Gasoline

For the gasoline engines powering the various types of equipment with which we are concerned in this article, the regular grades or housebrand gasolines should be entirely satisfactory. Octane ratings of these gasolines are now sufficiently high throughout the country so as to satisfy the octane requirement of even the latest types of equipment for construction service.

Volatility or distillation characteristics of modern gasolines are carefully controlled for quick starting, rapid warm-up, protection against vapor lock, and uniform performance with respect to power and economy. This controlled volatility is maintained not only to satisfy ever changing climatic conditions in a given area but also for any section of our vast country.

Diesel

The majority of the manufacturers of diesel engines used in construction machinery either specify a No. 2 grade of fuel or have established specifications which are usually broad enough to be met by a reputable supplier of diesel fuels of this grade.

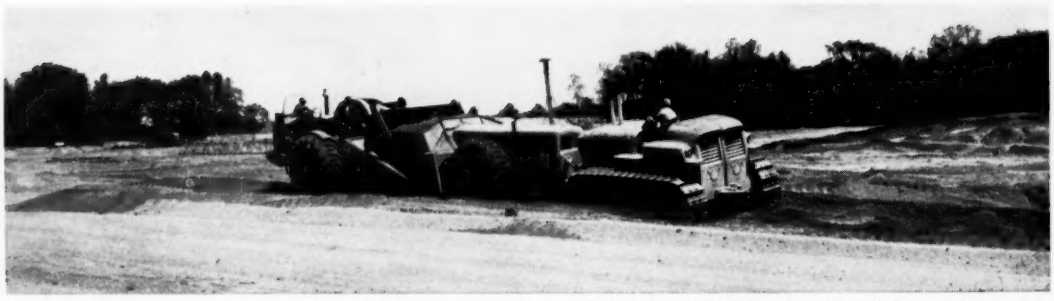
As a possible aid in selecting the proper grade of diesel fuel a table has been prepared showing the diesel fuel specifications of the majority of the diesel engine manufacturers whose engines are used in construction equipment. For comparison, the requirements of the ASTM Grades No. 1-D, and 2-D of Diesel Fuel are also shown.

STORAGE AND HANDLING

The petroleum supplier takes every precaution necessary to assure that lubricants are in the best possible condition when delivered to the customer. The user, likewise, should exercise equal care to see that when a lubricant is applied, it is in the same good condition as when it was received.

All of us know from experience the consequences of eating spoiled or contaminated food — illness, treatment, and doctor bills. Consequently, we take extreme measures to protect food and be sure that it is in satisfactory condition when we consume it. In a sense, fuels and lubricants are the food of machines. If fed spoiled or contaminated products, they, too, can become ill, and the treatment and "doctor bills" as represented by repairs and new parts can be very costly and expensive.

Many things can happen to a lubricant between



Courtesy of Euclid Division General Motors Corporation

Figure 4 — 906 Horsepower Combination of an 18-Yd. Struck Capacity Twin Powered Scraper Being Push-Loaded by a Twin Powered Crawler.

the time it is received by the customer and the moment it is applied. Such things as careless handling, contamination, confusion of brands, exposure to extreme temperatures, and leakage can result in damaged equipment, excessive maintenance cost, and lost productive effort. The conditions under which a contractor must store and handle lubricants are particularly hazardous from the standpoint of contamination and exposure to temperature extremes. Consequently, he should be unusually careful to see that nothing detrimental happens to them.

Leakage

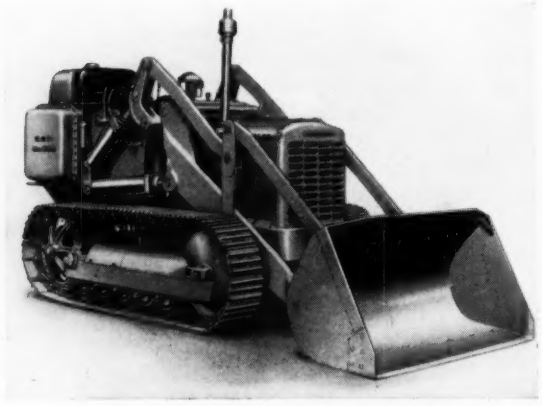
Loss of lubricant from damaged containers, loose fitting plugs, or careless handling (spilling) represents product that the user has purchased but will not be able to use. This all adds up to waste.

Contamination

All contamination is undesirable and should be avoided, but the extent of the consequences will vary, depending on the type of lubricant and the nature of the contaminants. In general, lubricants containing additives will be affected more adversely than will straight mineral oils. For example, a little moisture will not result in permanent damage to straight mineral oils. They may become cloudy but will clear up after standing as the moisture settles to the bottom. Certain additives, however, may be water sensitive and may be removed partially or completely by contact with just traces of water. Also water will cause separation or lump formation in certain type greases.

Contamination with dirt, dust, or other solid bodies can be especially harmful if not discovered in time. Not only do these materials accelerate oil oxidation and shorten oil life, but also because of their abrasive properties, they can cause severe damage to the moving parts of the machinery.

Thus, extra precautions should be taken to protect lubricants from contamination. At best it can cause extra handling if discovered before the product is used (filtering out solid particles or allowing water to separate). Furthermore, contamination may permanently destroy some of the important properties of certain additive type lubricants—properties which are essential for satisfactory lubrication of the equipment where the product is to be used. Finally, if the contamination is not detected, some very serious consequences can result, including damaged equipment, costly repairs, and lost production.



Courtesy of Caterpillar Tractor Co.

Figure 5 — 1-Yard Capacity Single Unit Tractor-Shovel

Extreme Temperatures

Exposure to either abnormally high or low temperatures also can result in temporary or permanent damage to lubricants, depending on the nature and composition of the product. Again, it is the additive type products which are most subject to harm.

Of the two extremes, contact with low temperatures is by far the more prevalent due to outdoor storage in areas where the winter weather is very cold. If nothing worse, exposure to low temperatures causes lubricants and greases to become viscous and stiff, making them difficult to handle. Various means are commonly used to heat products which have been subjected to low temperatures, some of which are not to be recommended. Where direct heat is applied, there is always danger of developing local overheating which may ruin the lubricant.

Dispensing

On construction operations in particular, it is most advisable, if at all possible, to apply the lubricant directly from the original container in which it came. The elimination of intermediate transfer receptacles erases a very serious source of contamination. Dispensing equipment is now available to fit all of the standard containers used to package lubricants and greases. They permit product to be removed from its original container with no danger of contamination, waste, or mess.

Storage Suggestion

Some "do's and don'ts" that apply to storage and handling of lubricants are outlined as follows.

1. Choose storage area carefully. Select a central location so that hauling distances are as short as possible. Also select an area where the atmosphere is free from dust and vapors.

2. Store lubricants indoors if possible—chances of contamination will be less.

3. If stored outdoors, drums should be placed on their side and on racks — don't lay them on the ground. When placed upright on end, rain water may accumulate and be sucked into the drum by the normal breathing action. If stored outdoors on end even temporarily, cover should be available to place over drum in the event of inclement weather.

4. Cleanliness is essential regardless of whether storage is indoor or outdoor.

5. Orderliness is another must. By keeping different brands and types of lubricants separated and in their proper places, there is less chance for confusion and error.

6. Don't store more products than necessary. The lubricant supplier will be glad to make a survey of lubrication requirements with a view to keeping the number of different products to a minimum. This also will reduce chances of confusion.

Courtesy of Allis-Chalmers Mfg. Co.

Figure 6 — Loading a Truck with a 2¼-Yard Crawler Tractor-Shovel.

7. Exercise extreme care in heating products that have been exposed to low temperatures. If possible, transfer drums to a warm area and allow product to reach room temperature. If more rapid heating is required, use exhaust steam. Never apply direct heat, such as a flame, to exterior of the drum. This could melt the sealing compound and cause leaking. It might also harm the product.

8. Remember that exposure to temperature extremes can damage lubricants. If there is any reason to suspect that this condition has occurred, examine the lubricant before using. If the product appears abnormal, consult the lubricant supplier as to what to do. The lubricant may have to be discarded or it may be salvaged.

PREVENTIVE MAINTENANCE

To the contractor striving to complete his job on time, equipment maintenance is (or should be) of prime importance. A piece of machinery which must be pulled off the job for repairs represents lost time. Also equipment not operating at top efficiency can have far reaching effects. For example, a sluggish

Courtesy of Allis-Chalmers Mfg. Co.

Figure 7 — Combination of a 15-Yard Struck Capacity Scraper and Crawler Tractor Engaged in a Highway Construction Operation.

Courtesy of Bucyrus-Erie Company

Figure 8 — 3-Yard Shovel with a Full Dipper of Granite Rock.

push tractor may upset the smooth operation of an entire fleet of scrapers; the breakdown of a single haul unit may mean delays to a big loader; and the breakdown of a loader—even for a short time—may delay a long series of operations.

Although the lesson has been learned the hard way, experience has proven that in the long run it pays to take care of equipment on the job and not neglect it. A program of preventive maintenance, well planned and properly executed, will pay for itself over and over again. For example, it is much cheaper to keep a bearing adjusted than it is to buy new bearings, shafts, and gears that become damaged when unadjusted bearings fail. Major breakdowns, lost time, and high operating costs can be kept to a minimum by keeping parts lubricated, tightened, and adjusted. Furthermore an operator whose equipment is always in good condition is very apt to be a happy, satisfied employee.

Since no two jobs are exactly identical, the actual details and execution of preventive maintenance programs will necessarily vary from job to job. However, there are a few basic concepts which are common and essential to all successful programs.

1. Set up a definite schedule for lubrication and mechanical check-ups and *stick to it strictly*. Any program will begin to fall apart and become ineffective once exceptions are made and one starts to "cheat" on the original schedule. For example, if it is found that the interval between lubricant changes can be increased a certain amount with no apparent adverse effect, the natural tendency then is to extend it further and further. Such practice will inevitably lead to disaster.

2. If possible, have the preventive maintenance work performed on an off-shift, as this will cause a minimum of interference with the productive effort.

3. Assign men to this job who are familiar with lubricants and who are thoroughly acquainted with the equipment. The consequences are too great to entrust this work to uninformed personnel.

4. Keep accurate records of the servicing done on each piece of equipment. This need not be a complicated procedure. A few simple check marks on a printed form are all that is required. A study of such records will usually serve as a warning of possible trouble. For example, excessive oil consumption is evidence of poor lube fittings or oil leaks – items which can be checked at once by the mechanic. Also these records will indicate when the machine is nearing the overhaul stage.

5. Keep on hand a stock of parts and expendable supplies—if they are available when needed, equipment requiring new parts will be out of service for a minimum amount of time.

6. Clean equipment before servicing. On the face of it, this may seem ridiculous since the machines will become dirty again as soon as they are put back in service. However there are two good reasons for following this practice. First, the lubrication fittings will be uncovered, and the chances of any points being missed will be reduced. Fittings caked over

with mud may be overlooked in accordance with the old adage "out of sight, out of mind". Second, there is less chance of dirt from the machine contaminating the lubricant at the moment of application.

These, then, are some points that should apply to any good preventive maintenance program. As mentioned earlier, the actual details of carrying out such a program must be worked out for each individual job. Usually, it is more difficult to set up an ideal program on short term jobs than on those that last for an extended period. As far as lubrication is concerned, the critical points are those which must be lubricated frequently and the critical time is at the start of the job.

SERVICE SUGGESTIONS

Some useful service hints on various parts of construction equipment are outlined as follows:

Air Compressors

Keep valves clean to avoid excessive discharge temperatures and keep receivers drained of any accumulated oil. Service air cleaners every 5 to 10 hours, if necessary.

Ball and Roller Bearings

Ball and roller bearings often have seals to prevent grease leakage. If seals are in good condition, a grease charge should last about 200 hours. Use a low pressure gun and apply only a few shots unless bearing is vented. Forcing grease around the shaft will break the seals. Fill bearing between a quarter and half full.

Brakes

Do not over-lubricate wheel bearings, as excessive lubricant may reach the brakes.

Since hydraulic brake mechanisms often contain rubber parts, use only approved fluids which will not affect them.

Cables and Wire Ropes

Do not lubricate cables that drag in the dirt. Cable winding on drums equipped with clutches should be lubricated sparingly to prevent the possibility of lubricant reaching clutch faces.

Other cables should be cleaned every 10-100 hours as necessary to avoid dryness, and cable lubricant applied.

About every 500 hours cables should be immersed for a minute or two in heated cable lubricant using a trough built especially for this purpose. Usually this is a horizontal trough equipped with pulleys arranged to keep the cable submerged while it is run through. A burlap collar wipes off excess lubricant before the cable leaves the trough.

Chains

In order to lubricate the pins of silent chains, remove chains every fifty hours, wash in Diesel fuel or kerosine and soak in hot gear oil.

Courtesy of Baldwin-Lima-Hamilton Corporation

Figure 9 — 6-Yard Shovel Moving Soap Stone and Sand Rock.

Courtesy of the Thew Shovel Co.

Figure 10 — 15-Ton Crane with Clamshell Bucket Loading Trucks in Sand Pit.

Clutches

Use low pressure gun and do not over-lubricate clutch parts. Lubricant on clutch facings will cause slipping.

Electric Motors

Inspect grease lubricated bearings every 2,000 hours. If grease has deteriorated or if dirt is present, clean and repack and add grease to housing until one-third full. Add small amount of grease every 1,000 hours but do not over-lubricate.

Check oil level of oil lubricated bearings regularly. Wash out bearings every 2,000 hours. Do not flood bearings and wipe off any excess oil.

Engines (Gasoline and Diesel)

Crankcase

The drain period recommended by the engine manufacturer covers normal operation. More frequent draining is necessary if oil temperatures are above normal, if engines are started and stopped often, or idled for long periods, if the atmosphere is very dusty, or if the oil has been diluted to facilitate starting. Generally, oil should be drained from engines of construction machinery at 50 hour intervals. Where operating conditions are not too severe, 100 hours drain periods are entirely practical. On the other hand, if the filter or oil shows excessive contamination, filter cleaning and oil drain periods should be shortened. Extending the oil drain period is poor economy, since additional wear and deposits due to greater oil contamination will cause greater maintenance and shorter equipment life. Copper or white metal specks on the filter often serve as warning of incipient bearing difficulties.

Drain oil while hot—this is a must! If the oil filter is removed when draining oil, add an extra quantity when refilling the crankcase. Check the oil level every 10 hours, after the engine has been stopped for a few minutes to allow oil in the upper part of the engine to return to the case. When changing brands of oil, even when manufactured by the same supplier, it is advisable to drain the crankcase at the end of the first 24 hours of operation to remove old oil deposits loosened by the new oil.

Crankcase ventilator air cleaners should be serviced when oil is drained.

Courtesy of Marion Power Shovel Co.

Figure 11 — Loading a Truck with a 10-Yard Shovel.

Courtesy of Link-Belt Speeder Corporation

Figure 12 — Loading Rock with a Power Shovel.

Air Cleaners

Air cleaners may be of the wire gauze type in which the gauze is either replaced with a new element or washed in kerosine or Diesel fuel, dipped in oil and reused. Usually any heavy oil (SAE 50) is satisfactory for coating the oil wetted type.

The oil bath-type cleaner requires inspection at 5 to 50 hour intervals to keep the oil at the proper level and the oil cup clean. Stick a screwdriver down into the oil, and if the sediment is one-quarter to one-half inch deep, the unit should be cleaned and refilled. The entire assembly should be taken apart and cleaned every 500 hours. Carryover of oil into the intake manifold indicates that the engine has been over-speeded, the oil is too light, or the air cleaner is too small. Do not remove the oil cup when the engine is running.

Centrifugal precleaners should be emptied when the glass container becomes half full.

Cooling System

To insure complete combustion and to avoid contaminating the lubricating oil with fuel soot, engine cooling systems should be maintained at about 180°F. This requires the use of shutters or other covering over the radiator when starting up or operating at light load in cold weather. In hot weather special attention should be paid to the fan belt, radiator, and water jacket to maintain the cooling system at maximum efficiency. Thermostats must be checked frequently by noting whether the radiator remains cold until the engine has reached proper operating temperature as shown by the indicator on the dash.

Permanent type anti-freeze solutions are preferred for construction machinery engines since alcohol boils at about 170°F. and most cooling system thermostats are set above this figure for efficient combustion of the fuel. Kerosine and salt solutions should never be used.

Distributors

The lower part of the distributor often is lubri-

Courtesy of Koehring Company

Figure 13 — Operation of a Crawler Mounted Excavator with a Dragline Bucket.

cated automatically from the engine. When driven from the generator, however, separate grease lubrication is usually required.

The upper distributor bearing may require either grease or oil lubrication. The wick under the distributor rotor requires two or three drops of light oil. An occasional touch of grease to the cam shaft is desirable, making sure, however that none reaches the breaker points.

Fans

Fans mounted on the extension of the shafts of other engine accessories and having no separate bearings require no lubrication. Neither do those having permanently packed bearings.

Some fans require occasional grease application, while others must be lubricated regularly with oil. One type of oil lubricated fan is equipped with an overflow while another is provided with a standpipe to insure constant oil level. In the latter type, the reservoir is filled with oil and the excess drained by turning the fan until the filler hole is down. If over-lubricated, fans may throw grease or oil on the belts.

Generators

Over-lubrication causes deterioration of windings and gum formation on the commutator.

Oil Filters

Clean or replace filter element at every oil change or more often under severe dirt conditions. Low temperature operation requires more frequent filter changing due to condensation forming an emulsion with the oil.

Oil filters do not remove fuel dilution or soluble oxidation products. Therefore, crankcase oil must be changed regularly regardless of the filter type. Bypass filters do not remove all of the finely dispersed soot. Consequently, where these filters are used, detergent oils may turn dark quickly in service. This is a sign that they are functioning properly.

Water Pump

Some require no lubrication, since they are lubricated either automatically from the engine or permanently packed at the factory.

Others have a wick leading from an oil sump and some have porous bushings through which oil seeps to the bearings.

Grease lubricated pumps in which the grease does not come in contact with the engine coolant (i.e., when the grease is applied to an external support bearing) should be lubricated with a general purpose grease. Those in which the grease does come in contact with the engine coolant (i.e., when the grease is used to lubricate the packing seal) should be lubricated with a heavy water insoluble grease.

If cooling systems show signs of oil, it is an indication that either too much or the wrong kind of grease is being applied to the shaft.

Gears — Enclosed

In most cases the oil need not be changed more often than every 1,000 hours, although the oil level in the gear boxes should be checked every 50 hours. Check the drain plugs after heavy rain or severe dust conditions, then drain and refill if water is present or if dust is getting in. Keep the oil seals in good condition to prevent leakage. Going to a heavier grade of lubricant does not necessarily reduce leakage, since under heavy loads the heavier oil will result in an increase in the gear case temperature which in turn will cause the lubricant to become less viscous. Foaming or overheating in gear boxes often indicates too high an oil level. This will also cause leakage. Keep vents open to prevent pressure build-up inside the gear case.

Gears — Open

Lubricants for open gears may be one of two types — those which must be heated and applied by brush or pouring or those which contain a solvent and are fluid at normal temperatures, thus permit-

Courtesy of Harnischfeger Corporation

Figure 14 — Operation of a Loader Teamed with a Crawler Tractor.

Courtesy of Unit Crane and Shovel Corp.

Figure 15 — Excavator Equipped with a Trenchoe Boom.

ting easy application. Shortly after application the solvent evaporates, leaving a thick viscous film of lubricant.

Gears should be inspected every 10 hours and more lubricant applied if necessary. Open gears operating in very dusty locations should be washed frequently with crankcase oil and no other lubricant applied. If gears must be run dry, reduce speeds and loads.

Grease Fittings

Wipe fittings before and after applying grease. When the plug must be removed and a fitting applied, it is an indication that this part should be be lubricated only occasionally. Most parts, such as plain bearings, should be lubricated frequently and freely by applying product until clean grease shows at the point where the old grease is forced out.

Hydraulic Systems

The pumps and valves of hydraulic systems are precision made, and a premium grade, inhibited oil should be used which will protect parts against wear, rust, and corrosion and which will have high resistance to foaming and the formation of gum and sludge. Gum and sludge formation may result in erratic motion and eventually complete stoppage of the system.

Check the oil level frequently and keep it constant. This will prevent air from being drawn into system which could cause foaming. If foaming occurs or if the oil level is low, check the system for leaks.

Power Control Unit

Operate the clutch firmly to prevent slippage which results in overheating, hardening of leather oil seals, and leakage.

Rubber Parts

Oils and greases may cause natural and some synthetic rubbers to deteriorate. Keep tires, fan belt, rubber hose, engine mountings, rubber bushings on radius rods and spring shackles, and cooling system connections free from fuel, oil and grease.

Use only approved fluids in shock absorbers, brake cylinders, and hydraulic control systems containing rubber diaphragms, plungers, or seals.

Steering Gear

Keep gear housing filled with recommended oil to lubricate gear surfaces, bearings, and steering shaft. Use a low pressure pump to prevent lubricant from being forced up the steering column.

Track Rollers

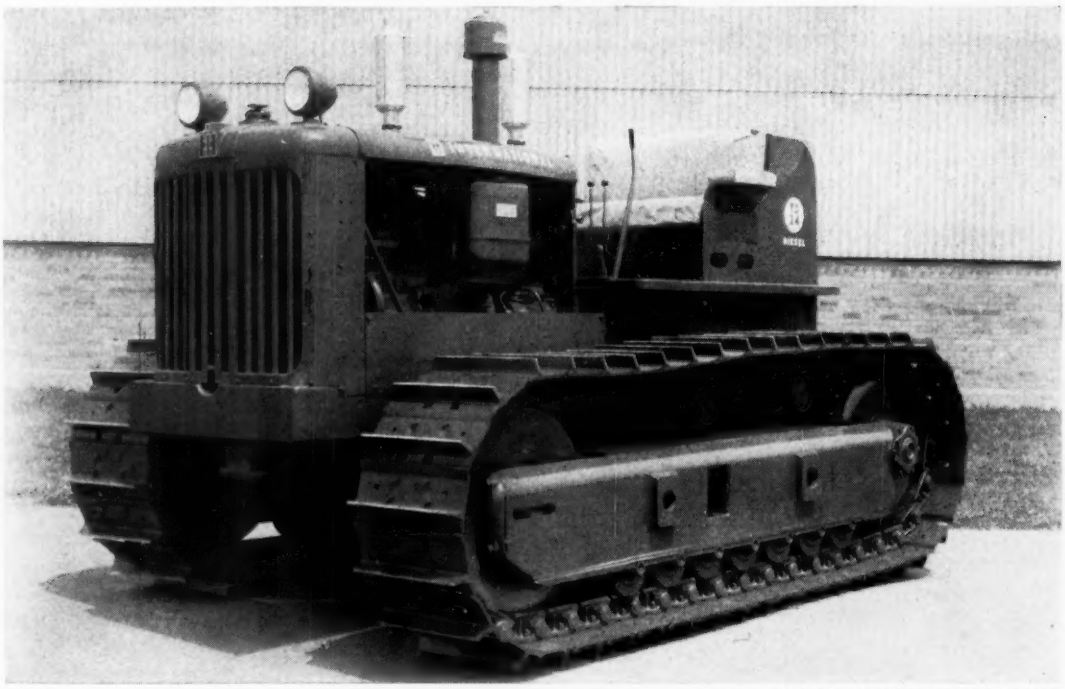
Track rollers of crawler mechanisms having plain bearings require frequent lubrication to prevent dirt and water from working in. Those on shovels, draglines, and cranes should be lubricated every hour when traveling.

Treads — Caterpillar Type

Do not lubricate. This refers to treads only and should not be confused with the track roller or idler assemblies. The pin between individual treads is designed to operate without lubrication as dirt or other abrasives which could be picked up by the oil would act as a lapping compound and shorten the life of the track.

Turntable Roller Path

Do not lubricate (except double flange type with



Courtesy of International Harvester Company

Figure 16 — Diesel-Powered Crawler Tractor with Torque Convertor.

hook rollers). Lubricant will cause rollers to slide and wear flat. Lubricate bearings of turntable rollers sparingly to avoid drip on paths.

Universal Joints

Some universal joints are provided with lubrication fittings. The ball and trunion type should not be over-lubricated as the boot will become filled with lubricant. Some roller bearing types require disassembly and hand packing by an experienced mechanic.

The propeller shaft splines usually are equipped with a fitting. The type of plug or fitting should not be changed as the balance of the rotating part would be affected.

Wheel Bearings

Front wheel bearings generally are lubricated by removing the wheels and repacking by hand.

Some rear wheel bearings have to be removed, while others are lubricated automatically from the differential or are permanently packed at the factory. Some are equipped with a grease cup or fitting, and still others have a plug which must be removed and a fitting substituted, the plug being replaced after the lubricant is applied.

Premature failure often is caused by contamination with dirt and dust during cleaning and repacking. Whenever wheel bearings are removed, they should be examined, washed carefully, and dried with air. After cleaning, grease should be packed around the bearings and the bearings replaced. Grease seals should be examined carefully and replaced if necessary. Ball bearings must be adjusted so that the wheel will turn freely with no end play. Only a small amount of additional grease should be placed in the bearing housing as overlubrication may result in grease on the brakes.

SUMMARY

Investments in heavy construction equipment and expenditures for construction projects are at an all time high and are expected to increase still further during the next few years. Over 20% of the total sum spent on construction operations is devoted to keeping equipment operating, but less than 1% of the total is spent on lubricants. In view of the recognized importance of proper lubrication to the performance and life of the machinery and the relatively low amount spent for lubricants, it is self-evident that compromising with lubricant quality is false economy.

Operating costs can be reduced to a minimum and equipment life can be extended by: (1) Adopting a simplified lubrication plan which will keep the number of lubricants on the job to a minimum but will still satisfy fully all of the lubrication requirements; (2) Storing and handling lubricants properly so that chances of contamination will be minimized; and (3) establishing a preventive maintenance program which includes periodic mechanical and lubricant check-up and following it to the letter.

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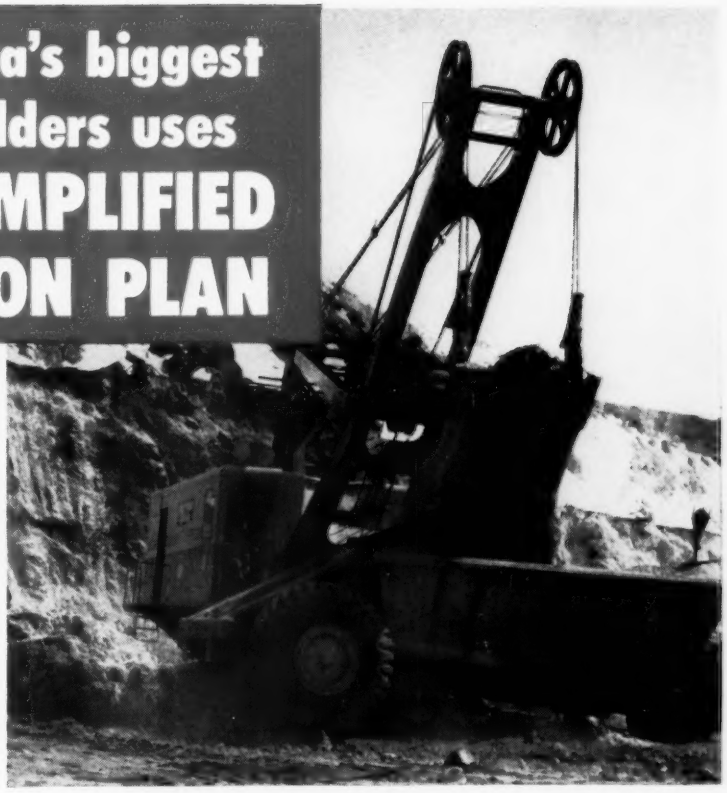
One of Nevada's biggest highway builders uses TEXACO SIMPLIFIED LUBRICATION PLAN



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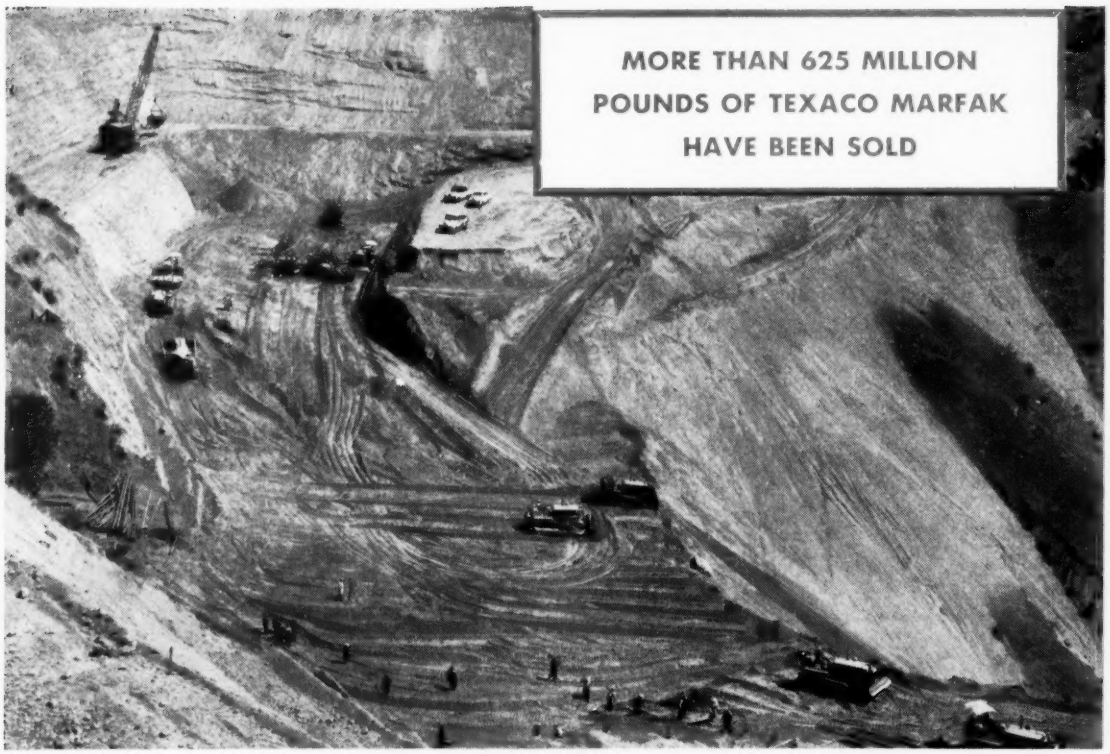

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